HEART BEATS DUST:
THE CONSERVATION OF AN INTERACTIVE INSTALLATION FROM 1968 AND
AN INTRODUCTION TO E.A.T (EXPERIMENTS IN ART AND TECHNOLOGY)

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ABSTRACT
This paper begins with a short historic overview of installations including electric
and electronic components in works of art from the United States. The roots of
this work go back to the 1960s, when artists and engineers started to collaborate
and create installations, eventually forming the pioneering group E.A.T. (Experi-
ments in Art and Technology). Today, these early technology-based artworks made
by E.A.T.—mainly in the 1960s—are relatively little known, primarily as a result of
the complexities of preserving, displaying, and properly maintaining them. While
technologically advanced at the time when they were created, some components
have become outmoded or obsolete and are hard to preserve (Davidson 1997, 290).
Keeping these artworks “alive” without changing their technological and functional
integrity is possible, to some degree, but there is a fine line between preserva-
tion, conservation, and re-creation, which will be addressed and discussed in more
detail.

COLLABORATION BETWEEN ARTISTS AND ENGINEERS IN THE UNITED STATES
In 1960, Billy Klüver (1927–2004), a Swedish-American engineer at Bell Tele-
phone Laboratories and the Swiss artist Jean Tinguely (1925–1991) started their
collaboration in building the self-destroying machine Homage To New York (1960)
in the garden of the Museum of Modern Art (MoMA) in New York City (figs. 1, 2).
Jean Tinguely and Billy Klüver worked on the machine for several weeks, collecting
materials from a garbage dump located in New Jersey. At night, they hauled bicycle
wheels, kitchen appliances, and other materials, hoisting them over the wall on
East 54th Street into MoMA’s garden in order to assemble the machine.

Klüver and his assistant, Harold Hodges, designed special step relays that closed eight electrical power circuits at different intervals over the course of 27 minutes. The incorporation of these relays permitted the machine to play a piano, turn on a radio, activate a chain saw, cut the playing radio in half, start one of Tinguely’s metamatic drawing machines, operate an Addressograph machine, trigger a chemical reaction that produced smoke, and so forth (Klüver and Martin 1997, 311).

Fig. 1. Jean Tinguely, Homage To New York, 1960, installation view at the Museum of Modern Art, New York, March, 17, 1960.

Robert Rauschenberg (1925–2008) was in the audience and an eyewitness to the performance of *Homage To New York*. “Rauschenberg thought that the H.T.N.Y. was so real, so interesting, so complicated, so vulnerable, and so lovely as life itself” (Klüver and Martin 1997, 311).

He was also fascinated by the process of the collaboration between an artist and an engineer in the construction of the machine (Klüver and Martin 1997, 311). Exactly seven minutes after the Homage To New York machine started its self-destruction, some gunpowder exploded in Robert Rauschenberg’s little mascot for the machine.

Fig. 2. Jean Tinguely, Homage To New York, 1960, installation view at the Museum of Modern Art, New York, March, 17, 1960.

Billy Klüver, the engineer, saw many parallels between contemporary art and science, both of which he considered to be concerned basically with the investigation of life. . . . [He had] a vision of American technological genius being humanized and made wiser by the imaginative perception of artists. . . . Klüver seemed to speak two languages, contemporary art and contemporary science. (Lovejoy 1997, 73)

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which he called *Money Thrower for Tinguely’s H.T.N.Y.* (1960) (fig. 3).

*Money Thrower for Tinguely’s H.T.N.Y.* consisted of a small, rectangular metal box with a perforated top and heating wires at the bottom, where Rauschenberg put gunpowder. Two large, spiral binding wire coils were fastened to the top of the box, one at each end, with their free ends bent together and intertwined. Rauschenberg inserted 12 silver US dollar coins into the coils. When the artwork was plugged into a power circuit,¹ the heating wires were activated, igniting the gunpowder and causing the coils to spring apart, throwing the silver dollars into the audience.

Rauschenberg always wanted to implement thinking and action in his artistic work. He saw his work as an active participant of its own environment and the viewer as an active participant in the work. The final piece was the result of the collaboration between its materials, the artist, and the viewer. Rauschenberg stated in 1963:

Getting the room into the picture was important because I always felt a little strange about the fixedness of a painting. . . . The use of mirrors and putting open areas in the painting for the wall. . . . To come through and be part of

the active image was a way to counteract that kind of stillness. (Klüver 1981, 42)

The mechanical and electrical investigations motivated Robert Rauschenberg—as many other artists at that time—to move away from two-dimensional surfaces (Davidson 1997, 290). Rauschenberg’s perception of the world began to include new technology. Technology was the new material on his palette. Billy Klüver gave him the suggestion that the possibilities in technology were endless. And of course, he was right (Rose 1987, 67 and Klüver and Martin 1997, 311).

**E.A.T.: HOW IT ALL BEGAN**

The collaboration between Billy Klüver and Robert Rauschenberg began shortly after the Homage to New York performance. Rauschenberg asked Klüver if it was technically possible to create an interactive environment that would allow the viewer to manipulate temperature, sound, smell, and light. In the following years Rauschenberg and Klüver worked on the idea of an interactive—or better, reactive—environment. Given the technology available at that time, it was hard to meet Rauschenberg’s visions. By 1962, Rauschenberg’s original idea was refined with the focus concentrated on the development of a “sound environment,” in which the sounds emanating from five AM radios could be manipulated by the viewer. With the use of a separate unit provided the viewer could control the volume and change the channels wirelessly.

Rauschenberg wanted the visitor to be able to vary the speed of scanning from station to station but to be prevented from staying at or tuning in to any given station. The engineers came up with the solution: the turning dial was operated by a small, variable speed, DC motor, and the visitor controlled the speed of the motor (Klüver and Martin 1997, 312). However, two complete versions were built and rejected because interferences between the control signals from the homemade AM transmitters and the AM radio signals generated a nightmare of noise.

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¹ The use of a separate unit provided the viewer could control the volume and change the channels wirelessly.
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(Klüver and Martin 1997, 312). In the summer of 1964, the technology caught up with Rauschenberg’s vision with the development of the first crystal-controlled, fully transistorized wireless microphone system, the Comrex system, with a transmitter and receiver (General Electric transistor radios) operating in a 30MHz range.

The five sculptural elements of the interactive or reactive environment Oracle (1962–65) are a metaphor for a gift of the street. Oracle was basically made from a car-door, a typewriter desk, a concrete mixing container (including the pump for the circulating water shower), an air flue (vent) pipe, and a window frame (fig. 4). Many choices in the creation of Oracle were not made purely on the basis of engineering considerations but were aesthetic choices: Rauschenberg chose the size and shape of the control knobs, the size of the speakers, and where to place the technical components in each piece (Klüver and Martin 1997, 312–313).

By the time Oracle was created, Klüver had already made numerous contacts with artists, inviting them to Bell Labs. In 1965, a group of New York-based artists prepared a proposal for an Art and Technology festival. Rauschenberg and Klüver invited the composers John Cage (1912–1992) and David Tudor (1926–1996), the choreographers Lucinda Childs (b. 1940), Deborah Hay (b. 1941), Steve Paxton (b. 1939), and Yvonne Rainer (b. 1934), and artists Öyvind Fahlström (1928–1976) and Robert Whitman (b. 1934) to participate. The resulting group-planned performances took place in 1966 at the 69th Regiment Armory Hall in New York and were entitled 9 Evenings: Theatre and Engineering—A Series of Performances by 10 Artists Collaborating with 30 Engineers (fig. 5).

At the first meeting for the event, Klüver asked the artists to present their questions and concerns relating to their technological needs. In return, he asked the engineers to respond to these and come up with ideas and solutions.

9 Evenings intensified interest among New York artists in using new technologies and created so much enthusi-
asm among both artists and engineers that, in response, Billy Klüver, Robert Rauschenberg, Robert Whitman and Fred Waldhauer (1927–1993) founded the non-profit organization Experiments in Art and Technology (E.A.T.) on October 10, 1967 (fig. 6).

E.A.T. was formally launched at Rauschenberg’s studio—or more precisely in his studio chapel, a building that had at one time been used as a catholic orphanage.² To show the possibilities of artists and engineers working together, a one day exhibition of artworks incorporating technology was held in Rauschenberg’s house and included such pieces as: Andy Warhol’s (1928–1987) helium filled Silver Clouds (1966); a large computer generated nude by Ken Knowlton (b. 1931) and Leon Harmon (1922–1982); Robert Whitman’s film sculpture Shower (1964); and a roomful of noisy environment like Rauschenberg’s Oracle.³

In an interview with The New York Times in 1967, Robert Rauschenberg was asked about his motives to engage with E.A.T. He responded in a very provocative way for that time, saying, “If you don’t accept technology you better go to another place, because no place here is safe. . . . Nobody wants to paint rotten oranges anymore” (Lieberman 47) (fig. 7).

Like many other artists of the time, Rauschenberg thought that art that eliminates and factors out technology consequently loses its social relevance. While he wasn’t as radical in his thinking as the constructivist and futuristic artists of the 1920s, he strongly supported the collaboration of artists and engineers.

At the time E.A.T. was founded, Rauschenberg reiterated his idea for a room that would be responsive to weather, noise, light, and to the people viewing it. Soon after, he expressed interest in making an artwork with proportionally controlled lights. The realization of this vision was possible due to innovations made during 9 Evenings in which the participating engineers developed a system that changed the intensity of illumination of a light bulb in proportion to the loudness of a sound signal by using a silicon controlled rectifier, or SCR, circuit that had just appeared on the market at that time. The first artwork to incorporate this technology was made by Rauschenberg in collaboration with E.A.T. members, called Soundings in 1968.

Soundings is an eight foot high and thirty-six foot long wall made of three layers of acrylic sheeting (fig. 8). The front layer has a mirrored surface and behind it are two layers of acrylic with black and white screenprinted images showing a chair in different angles. Soundings

Fig. 7. Newspaper clipping of Henry Lieberman’s article, “Art and Science Proclaim Alliance in Avant-Garde Loft” in The New York Times (1967).
is an interactive room installation created to envision Rauschenberg’s desire to have the viewer interacting and talking to the artwork. When the visitor walks into the room silently, the person will see nothing but the mirrored image of themselves. If the visitor starts clapping their hands or starts speaking or singing, microphones above the installation pick up the audio signal and different lights illuminate the inner layers of acrylic in relation to the frequency of the individual voice.

The system is so sensitive to different ranges of the human voice, using four frequency bands that respond individually, that different people who speak the same words will cause different visual effects. Rauschenberg’s intent was to create a one-to-one response between the art and the viewer, reinforcing and making tangible the concept that art literally “talks” to individuals differently.

In the instance of Soundings, the complexities of preserving an interactive installation can be discussed in more detail. While installing and de-installing this artwork at four venues during Robert Rauschenberg: A Retrospective by the Solomon R. Guggenheim Museum, New York City, from 1997 to 1998, the author realized how extremely vulnerable those artworks are.

As discussed above, upon the creation of E.A.T., the participating engineers developed a method for altering the intensity of illumination of a light bulb in proportion to the loudness of a sound signal. This was and continues to be a highly vulnerable system as any degree of disconnection or incorrect wiring of the audio intake can result in an installation that could be considered fatally improper in its contradiction to the artists’ intent and destruction of its sensitivity. Conserving an interactive installation means knowing how to put it together in every single detail, a factor that stresses the importance of meticulous documentation as being essential for the preservation of the authenticity of the work and an active part of conservation.

THE MACHINE AS SEEN AT THE END OF THE MECHANICAL AGE AND SOME MORE BEGINNINGS

In 1968, the exhibition The Machine as Seen at the End of the Mechanical Age was held at MoMA in New York, addressing the developments in art and technology over time and documenting the vibrant contemporary forces of E.A.T. For this exhibition, MoMA specifically invited E.A.T. to collaborate on a section dedicated to new technology (fig. 9).

E.A.T addressed this invitation by organizing a competition encouraging both engineers and artist to submit current contemporary artworks that reflected collaborations in art and technology. The winning artworks where selected and included in the exhibition, curated by the Swedish curator and art historian Pontus Hulten (1924–2006), who intended to show 10 medium size E.A.T. artworks in the MoMA show.
The overwhelming response to the competition announcement resulted in the submission of approximately 200 works from nine countries. While only ten artworks were slated for the MoMA exhibition, the remaining submissions were of such interesting artistic variety, that the decision was made to exhibit them concurrently with MoMA’s *The Machine* exhibition. In very short notice, exhibition space was found at the Brooklyn Museum. This additional show for the roughly 200 technology-based artworks was entitled *Some More Beginnings: An Exhibition on Submitted Works Involving Technical Materials and Processes, New York, E.A.T., 1968* (fig. 10).

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The winning entry of the competition, shown at the MoMA exhibition, was Heart Beats Dust (1968) by artist Jean Dupuy (b. 1925) and the collaborating engineer Ralph Martel (b. 1935) (fig. 11). The jurors issued their statement for the first prize as follows:

In each of the winning entries a spectrum of technology was used with great impact on the art forms. Evident is the realization that neither the artist nor the engineer alone could have achieved the results. Interaction must have preceded innovation. . . . The unexpected and extraordinary, which one experiences on viewing these pieces, result from inventiveness and imagination, stimulated not by the brute force of technical complexity but by probing into the workings of natural laws. (Lovejoy 1997, 72)

Heart Beats Dust is an interactive sculpture of dust, with a propulsion system that is activated by sound. The physical structure of the artwork is a black rectangle box with a window at eye level. A bright cone of light behind this window is supplied by a stage light from overhead of the black box. The dust contained within is Lithol Rubine, a brilliant red pigment of low specific gravity, chosen for its ability to remain suspended in air for long periods. The audio intake is archived from an electronic stethoscope.
scope that is placed on the heart of the visitor amplifying the heartbeat. A rubber membrane covers the speaker and the red pigment is placed on the membrane. The speaker makes the membrane vibrate which throws the pigment into the cone of light. The red pigment dances in the cone of light, some pigment shooting high and scattering, some falling heavily back.

When the author first examined the artwork in late 2006, it was in storage in a basement and, according to the owner, not in exhibitable condition. The owner, the Emily Harvey Foundation, New York, had received previous advice from an engineer to completely update all the technical components of the interactive installation. An update of the technical components from 1968 to 2006 technology would have resulted in a consequent loss of Heart Beats Dust’s integrity within its authentic and historically important technology.

Consequently, the owner was convinced by the author to preserve the artwork with a more respectful approach that prioritized the authentic technological integrity of the work with the highest respect. After the first examination, the following components were identified: black plywood vitrine (84 x 24 x 24 in.); active cube (24 x 24 x 24 in.); ¼ in. glass, rubber membrane; Lithol Rubine red (reddish synthetic azo dye); CI Pigment Red 57; amplifier (20–20000 Hz); electronic stethoscope; analog stethoscope; 12 in. coaxial speaker; Kiegl stage light (shuttered); and tungsten halogen lamp (250W).

In preparation for testing and re-installation of the artwork, initial steps were performed in the order listed below:

1. Documentation of all components
2. Opening electronic components and cleaning off accumulated dust
3. Cleaning electronic connections and removal of corrosion products
4. Condition checking of the rubber membrane
5. Checking the acoustics created by the original amplifier and stethoscope provided (the author was not able to create a clear signal)
6. Checking the acoustics created by the original stethoscope on a different commercial amplifier (the author was able to create a clear signal)

Besides the essential problem of the audio signal, the other components (particularly the rubber membrane, the speaker, and the light) were in a good condition. So, the main question for further treatment was to identify the reason for the audio interferences.

Consequently, this lead the author to question which audio frequency range our hearts operate. A human heart produces an audio output in the 50–450 Hz range. A commercial amplifier, like the amplifier provided with the artwork, covers the range 20–20000 Hz. It became obvious, that pre-amplification was needed to create a clear audio signal. There was no preamplifier within the components of Heart Beats Dust; however, it was possible to identify the company that fabricated the electronic stethoscope, as Medetron, Electronic Stethoscopes, Tokyo, Japan.

On eBay.com a contemporary preamplifier produced by Medetron was identified for auction. The delivered preamplifier connected well to the existing stethoscope.

![Fig. 12. The replacement preamplifier. Medetron, Electronic Stethoscope, Medelec International Corp., Tokyo, Japan.](image-url)
and covered two frequency ranges: low tone at 20–200 cycles and high tone at 50–1500 cycles.

Once the preamplifier was connected with the stethoscope and to the original amplifier, a clear acoustic signal was created resulting in dancing pigment in the cone of light of Heart Beats Dust. Every visitor had to adjust the frequency range on the preamplifier individually and maintain some distance to the artwork to avoid audio interferences.

After the completion of the conservation treatment, the author discovered the image in figure 13, which shows Jean Dupuy, Jean Tinguely, and Alexander Calder (1898–1976) in front of Heart Beats Dust in the Museum of Modern Art. Jean Dupuy is holding a small box in his hand—the missing preamplifier that was now replaced with an identical contemporary preamplifier.

The example of the conservation treatment of Heart Beats Dust clearly shows how vulnerable those early installations are to becoming inoperable and to unintentional modification, especially those early interactive installations using analog technology that was specifically modified according to the artist’s intention. But Heart Beast Dust is also an example that there is a slight chance to keep those artworks functional in their historic and technological integrity if we conserve them today while analog components are still in existence as well as the knowledge of their use.

Conservators today cannot pass this responsibility on to future generations of conservators born into a digital age, who may lack the knowledge and hardware components necessary to preserve analog technology. From the author’s point of view, this is one of the most pressing and challenging responsibilities electronic media conservators face today: to preserve those pioneering works—including their analog components—for future generations, while the knowledge and equipment is still available, so early technology-based artworks are not gone—in a heartbeat!

NOTES
1 It is questioned if the Money Thrower for Tinguely’s H.T.N.Y. really worked the way as described in the literature.
2 Before Rauschenberg turned that part of the building into his studio, he had it deconsecrated by a priest.
3 Oracle reflected Rauschenberg’s special sense of humor in its understatement, irony, and hilarious sense of absurd juxtaposition. At the very least, Oracle gave E.A.T a noisy send-off.
4 In 1997, Billy Klüver inspected Soundings with the intent of making technical modifications that would be more reflective of the artists’ original desire at the time of creation: to make the installation as dynamic as possible. Between the time the work was last shown, in the early 1980s at the Museum Ludwig, Cologne, Germany, and when the modifications were made in 1997, the SCR (silicon controlled rectifier) was no longer available and had to be replaced by Billy Klüver.
Whether or not this replacement resulted in a dramatic increase in the responsiveness of this artwork has been discussed intensively. However, without sufficient video documentation of the first installation of *Soundings* and the in-depth documentation of all its hardware components at its inception, the degree to which the artwork has been changed may never be quantifiable. This points again to the importance of documentation of electronic media artworks as an active part of conservation.

## REFERENCES


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